

BUREAU OF SUGAR EXPERIMENT STATIONS
BRISBANE

THE
CANE GROWERS'
QUARTERLY BULLETIN

ISSUED BY DIRECTION OF THE
HON. F. W. BULCOCK, MINISTER
FOR AGRICULTURE AND STOCK

1 OCTOBER, 1933

FREDERICK PHILLIPS, GOVERNMENT PRINTER, BRISBANE

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The Cane Growers' Quarterly —Bulletin—

VOL. I

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No. 2

Fertilizers for Sugar Cane.

By H. W. KERR.

IT has been pointed out on several occasions that the cane soils of Queensland are not possessed of the high degree of fertility which is so frequently attributed to them. Certainly there are restricted areas of highly productive soil, such as portions of Freshwater and the Burdekin Delta; but, in common with other tropical lands of heavy rainfall, the plantfood supply of the soil has been rapidly depleted, due to the excessive leaching to which they are subjected; the first flush of high productivity for which they are noted when first brought under cultivation rapidly passes, and the farmer must then pay very close attention to the maintenance of fertility if he would continue to harvest satisfactory crops.

Although a large proportion of our canegrowers are consistent users of fertilizers, there are still many who do not devote to these materials the attention which their importance demands. It is pleasing to note that the early prejudices which were entertained against these valuable materials are rapidly disappearing; but even to-day artificial manures are spoken of as crop stimulants—substances which transmit to the crop an unhealthy growth impetus, and which will eventually ruin the land. Used wisely, nothing could be further from the truth. Fertilizers are simply concentrated forms of plantfood, the application of which to the land serves but to restore something of the fertility which continuous cropping to cane removes from the land.

Sugar-cane must be regarded as a gross feeder on the plantfood of the soil. Calculations based on analyses show that a ton of cane removes as much plantfood as would be supplied by 25 lb. of mixed fertilizer. A 30-ton crop would, therefore, deprive the soil of the equivalent of 750 lb. of mixed manure. Is it to be wondered, then, that the harvesting of heavy cane crops without heavy manurial applications to the land soon results in rapidly declining crops?

It has been shown that crops extract from the soil seven plantfood materials which are absolutely essential to growth. If one of these is lacking, crop production is impossible; if one or more is present in deficient amounts, yields are reduced proportionately. In practice it is found that three of these plant foods in particular are likely to become factors limiting crop growth; they are nitrogen, phosphoric

acid, and potash. It is for this reason that *mixed* fertilizers contain these three plant foods in varying proportions. Other manures, such as superphosphate or sulphate of ammonia, supply only one of these particular foods.

As might be expected, soils vary widely in their ability to supply the desired amounts of these individual foods, and, therefore, the particular fertilizer mixture which will give most profitable results will vary in composition for different soil types. Thus the red volcanic soils of this State show a consistent deficiency with respect to potash, and a suitable mixed fertilizer should, therefore, be rich in this plant food. On the other hand, the acid alluvial soils of North Queensland exhibit very marked response to heavy applications of phosphates, but are able to provide for the potash needs of heavy crops of cane without substantial dressings of this plant food.

The determining of the particular requirements of the major soil types of the sugar areas has been one of the projects pursued intensively by the Bureau during the past four years. Fertilizer trials have been established on suitable areas of typical soil, and on the basis of the crop yields from the several treatments we have been able to select that fertilizing mixture which might be expected to return the grower the maximum profit for the value expended. In the far northern areas our trials have been particularly successful, and we are able to advise growers with a reasonable degree of certainty just what their soil most requires. This is certainly true for the red volcanic, alluvial, and gravelly soils of those parts. As regards the red schist soils, which rival the alluvials in point of importance in those districts, our results have not been so clear-cut. Certain of these soils exhibit marked response to potash-rich mixtures, while others—often not more than a mile away—have been found to be distinctly deficient in available phosphates, while the increased yield due to potash is of minor importance. It does appear, however, that our laboratory chemical tests on soils of this type reflect these conditions, and we would urge growers farming this particular type to submit samples to our laboratories for analytical purposes and advice.

If any doubt exists in a grower's mind as to whether the fertilizer he is using is suitable for his particular conditions, he should consult our Field Officer or Station Chemist, who will advise him of our findings, or will undertake to submit a soil sample for analysis should this course be deemed advisable.

The soils of the Burdekin area have already been mentioned. Here it is found, by field trial, that the richer soils of the area show but slightly increased yields from phosphates or potash, but phenomenal increases have been recorded following applications of sulphate of ammonia. This is particularly true of ratoon crops. One such experiment harvested during the present season showed 39 tons of cane per acre unfertilized, and 53 tons per acre where liberal dressings of sulphate of ammonia had been given. It now appears quite definitely that the failure of ratoons in that district is attributable in a large measure to inadequate supplies of plant food early in the lifetime of the ratoons, and this is especially true of the plant food nitrogen.

Our results in the central and southern areas have not been so complete as those in the far northern districts. This is doubtless due to the decidedly droughty conditions with which these areas have been

afflicted during the period under review. It must not be concluded, however, that our results have supported the oft-repeated statement that fertilizers are not required on these soils. On the contrary, it might be demonstrated that in a dry year the richer soil definitely outyields the poorer one; but the fact is that soil moisture has been so seriously deficient that the added plant food was not able to demonstrate its true value. It is hoped that a return of favourable seasons may enable us to prove this contention in no uncertain manner.

For the present we can only state that the red volcanic soils of these parts require a mixture rich in potash, and that forest sandy loams are usually lacking in available phosphates.

So far very little has been said regarding nitrogen—the plant food supplied by sulphate of ammonia. Our experiments have shown that practically all soil types give markedly increased yields where this material is applied. The nitrogen content of the land is intimately associated with the soil humus; and soils deficient in humus are, therefore, deficient also in nitrogen. This is particularly true of older lands, on which continuous cultivation over a period of many years has resulted in a rapid loss of humus. The ploughing-under of green manure crops on all soil types is to be definitely encouraged, therefore, if for no other reason than that the practice affords a cheap and ready means of building up a supply of available nitrogen in the soil. Indeed, we have found that, where a good crop of beans or peas has been ploughed under and rotted prior to planting cane, very slight response to added sulphate of ammonia can be detected.

The favourable influence of the leguminous crop is, however, fleeting; for the subsequent first ratoon crop has almost invariably shown a highly increased yield due to top-dressings of sulphate of ammonia. This fact should, then, be kept clearly in mind—that, although the plant cane may find all of the nitrogen which it requires for its growth, the ratoons will certainly benefit from application of this plant food. On certain of our soil types we have found that applications of 600 lb. of sulphate of ammonia per acre to ratoons are profitable. This is, of course, applied in two or three light dressings.

As regards the time and manner of applying fertilizer, we would suggest the methods which have been followed in all of our trials with success. To make best use of the supplementary plant foods applied in this manner, the crop should be able to draw on them as early as possible in its lifetime. For plant cane we would, therefore, recommend that the manure be placed in the drill with the cane plants; for ratoons, apply in a furrow 3 or 4 in. deep run close to the line of stools at ratooning time. Our experiments show that fertilizer applied early may result in added crop yields of several tons per acre, as compared with the same manure applied later.

This recommendation regarding the placing of the manure is not strictly accurate. In other words, we recommend that all phosphates and potash be applied at planting or ratooning time, together with a proportion of the nitrogen—for preference, in the form of meatworks manure. The bulk of the nitrogen is applied later in the form of top-dressings of sulphate of ammonia. It is found that best results follow this method of fertilizer application, and sulphate of ammonia appears to give maximum increases when applied in dressings each of 1 bag per acre. Thus it is desirable to apply such a dressing when the

plant cane is stooling, and probably another of similar amount from four to six weeks later. For ratoons, an application should be made shortly after ratooning, and in this case two further dressings—at, say, monthly intervals—should be given. It should be remembered that heavy dressings of sulphate of ammonia applied late in the season result in delayed maturity and marked reduction in the c.e.s. of the crop. As far as possible, growers should aim at completing their fertilizing programme before Christmas time. Sulphate of ammonia may be applied—always as a top-dressing—even in dry weather; it is then ready for absorption by the soil with the first rain that falls, and becomes of benefit to the crop immediately.

Trials with the Stubble Shaver in the Burdekin District.

By A. P. GIBSON.

IT has been pointed out repeatedly that high cutting of cane, or even of hilling up plant crops, materially reduces the crop yield of the subsequent ratoons. The development of suitable machinery to deal with this encumbrance has been slow. At first sharpened hoes were tried, but this proved too costly. Later the disc harrows, and, to a lesser degree, the rotary hoe were introduced to destroy the topmost eyes of the stubble and to break down the soil mound formed under irrigated conditions in the Burdekin. The resulting work has not been entirely satisfactory. The stubble is split and shattered somewhat, and this condition permits of the easy ingress of pests and fungi, and also hastens decay.

The recently imported implement known as the Stubble Shaver (which was described in the July issue of the Quarterly Bulletin) has been tried out in the Burdekin area during August, and has created a very favourable impression. It is strongly constructed, simply controlled, and is light of draught, although it weighs 13 cwt., and thus ensures a positive drive for the cutting discs.

The discs have remained sharp throughout the period of the trials, and they have shaved the entire width of the stool perfectly, at the same time sealing the cut and covering splendidly with a shallow soil mulch; this is a most important feature.

The machine has worked at speeds up to $3\frac{1}{2}$ miles per hour, and at depths ranging from 3 to 5 inches, according to the height of the soil mound.

For comparative purposes, alternate tramline strips were shaved, and the results are excellent. The shaved stubble shoots are coming more strongly and speedily than on the area treated with the rotary hoe.

This is doubtless the implement which growers have been seeking for a long time, and its work easily overshadows that of any other implement tried out hitherto. It allows growers to keep the stools well in the ground, and thus ensures superior ratoons.

What are the Losses Due to Red Stripe (Top Rot) Disease?

By ARTHUR F. BELL.

DURING the early part of the 1932-33 season a great deal of apprehension was caused in certain parts of North Queensland by reason of the amount of top rot and death which occurred in the variety Badila as the result of red stripe disease. While not wishing by any means to create the impression that red stripe is not an important disease, there is not the slightest doubt that the effects have been very greatly over-estimated, and it is the object of this short article to submit some of the facts which prove this statement.

Red stripe is a bacterial disease of sugar-cane, and has been reported from most sugar-cane countries. It is primarily a leaf disease, and is first noticed in the form of blood-red stripes towards the base of the leaves. Single stripes are about one-tenth of an inch wide, but numbers may run together to give broad bands, or, frequently, the whole of the leaf base may be red. The bacteria ooze out through the pores of the leaves and are carried from plant to plant by wind-splashed rain, so that in wet weather a whole field may rapidly become infected from a few diseased plants. As a rule, the disease makes its appearance with the first heavy rains, and the red striping may be common from October onwards. The disease may remain confined to this leaf-infection stage and disappear after a time, or the bacteria may pass right down into the heart of the stem, kill the growing point, and cause the well-known evil-smelling top rot. The red leaf-stripe stage is of little importance, and damage to the crop is not done unless the top-rot stage is reached.

For the most part, appreciable amounts of top rot occur only in late-planted cane or late-cut ratoons. Following particularly dry spring weather, this may not hold true in dry soils; and in the Mulgrave district, for example, as emphasised by Mr. M. J. Hoare at the last Technologists' Conference, there was last year a very considerable amount of death in fields of early plant cane. In the Johnstone district, however, early planting of Badila is usually all that is required to control the disease in that variety. Unfortunately, of course, it is not always possible to plant all fields early, particularly in areas such as Goondi.

Death of Badila from red stripe has been much more in evidence during the last five years, and the fear has arisen that Badila is "running out." As a result of careful observations, this increase in death is considered to be due mainly to the following factors:—(1) abnormally dry springs which have prevailed; (2) increased use of fertilizers; (3) increased tendency on the part of many farmers to plant setts too close in the drill. The climatic conditions which most favour the development of the top-rot stage are that there should be a prolonged dry spell in the spring, so that the growth of the cane is severely checked, followed by heavy rain, whereupon the cane makes sudden succulent growth. At least three of the last five seasons have been characterised by exceptionally dry spring weather, together with a large proportion of late planting, and last year this was particularly the case. At the same time, death from top rot was probably the greatest observed in recent years. With regard to fertilizing and close planting, we have gathered statistics which show that, generally speaking, the percentage of top rot is proportional to the number of stalks per acre. When suitable fertilizer is

applied, there is naturally an increase in the number of stalks per acre, and so the percentage of death tends to increase; but it must be emphasised that the increased yields from the fertilizer far outweigh any extra loss from top rot. Similarly, the close planting of cuttings increases the number of stalks per acre, but these stalks are lighter and weaker than is the case when the cuttings are spaced further apart in the drill. Experiments are being conducted to determine the most suitable spacing of cuttings in the case of Badila, in order to reduce the amount of disease without reducing the yield.

It is a matter of common knowledge that, even in the absence of any diseases or pests, by no means all the shoots which come through the ground survive and make cane, but probably few people realise how high is this natural death rate, due to crowding out. In Hawaii it has been found that with normal H. 109, free from diseases or pests, the average number of shoots which survive and are harvested (two-years-old crop) is only 25-30 per cent. Some similar experiments were carried out at the Mackay Sugar Experiment Station with one-year-old cane, and here it was found that only 35 per cent. of the shoots produced marketable cane. It will be seen, therefore, that even in the absence of any diseases and pests we must expect the natural death of the greater part of the shoots produced, due to competition for food, water, and light, and crowding out. Consequently, many of the shoots which die from red-stripe top rot would have died anyway, and in such cases the disease has no significance; this fact must be taken into account when attempting to estimate losses.

Turning now to the question of the extent of loss which result from the death of those shoots which would have produced marketable cane, we must consider the important factor of compensation due to increased growth of the remaining stalks in the stool. Take, for example, the case of a stool in which death due to overcrowding has already taken place and eight stalks are left, each producing millable cane, and suppose that at this stage two stalks are killed by top rot. We should not by any means be justified in computing this loss at 25 per cent. The remaining six stalks have now considerably less competition for food, moisture, and light, and they grow taller and stouter than they would otherwise have done, and so the amount of loss is proportionately reduced. The amount of this compensation will naturally depend on the period which will elapse before harvesting—that is, the amount of time left for the extra compensating growth to take place. Death from red-stripe disease takes place from October to March, and, of course, the greatest loss will occur when death takes place in March. Consequently, in order to determine the smallest amount of compensation which will occur, we set out experiments in which we killed varying percentages of Badila cane in the latter part of March, the crops being harvested five to six months later. As a result of these experiments, we believe that we can safely expect 40-50 per cent. compensation even if *all* the death takes place as late as the end of March. The earlier the death takes place, of course, the greater the compensation and the less the loss.

In recent years sugar-planters in Java have been greatly worried by the depredations of an insect called the "top borer"; this insect bores into the heart of the cane stalk and kills it, the nett effect therefore being very similar to that of a stalk killed by top rot. The death from top-borer damage usually takes place much later than is the case with top rot, but nevertheless the possibility of compensation due to increased growth of the remaining stalks was recognised, and the Java

Experiment Station decided to test the matter thoroughly by field experimentation. Five, 10, and 20 per cent. of the stalks were destroyed in different experiments. When the stalks were killed within four months of harvesting, the amount of compensation was 32 per cent. (that is, if 10 per cent. of the stalks were killed, the loss was not 10 per cent. but 6.8 per cent.); four to six months from harvesting yielded 49 per cent. compensation, and six to eight months 56 per cent. It will be seen that this is in agreement with our experience of a 40-50 per cent. compensation for death five to six months before harvesting, but in the case of red stripe, of course, this is the minimum amount of compensation. When death occurs early in the season—say, in October-November—the compensation factor is much greater, and we may expect up to 20 per cent. death without appreciable loss of crop.

Last year death of shoots commenced in October and caused a great deal of anxiety amongst farmers. This was particularly so in the Goondi district, where there has developed the opinion that Badila is "running out" and will have to be discarded. We can find no evidence that red-stripe disease is causing Badila to deteriorate, and, indeed, we would not expect this to be the case, since the disease is carried in the setts only in exceptional cases. A glance at the following table will give excellent support for our contention that death early in the season is usually of little importance. This table shows the average yield of Badila (plant and ratoon) per acre for the Goondi Mill district over the past four seasons:—

Year.	Tonnage per acre.				
1930	22.8
1931	25.1
1932	22.0 (flood damage estimated at over 7,000 tons).
1933	over 25 (estimated).

Thus it will be seen that, in spite of the claims that top rot is sounding the death-knell of the variety, and in spite of a fair proportion of death in the young cane, the yield per acre promises to be a record. Surely these figures must show that red-stripe top rot is not the bogey it is frequently made out to be!

Experiments are being continued in the matter of the spacing of plants in the drill in order to arrive at the most suitable distances and the effect of the time of application of nitrogenous fertilizers. At the same time we are investigating the possibilities of effecting control by the addition of certain cheap chemicals to the soil. In addition, varietal resistance trials are conducted each year, and as a result of last year's trials some promising seedlings, of high resistance to top rot, were discovered.

P.O.J. 2878 in the Moreton Area.

In the last issue of the "Quarterly Bulletin" we published a photograph of a standover crop of P.O.J. 2878 growing on the farm of Mr. D. McDonald, Bli Bli, Nambour. This crop was harvested immediately the Moreton Central Mill commenced crushing on 16th August last, and farmers in the southern districts will doubtless be interested to know that this crop cut out at the rate of 55 tons per acre, and the c.e.s. average of four mill tests was 14.6 per cent.

Army Worms and their Control.

By R. W. MUNGOMERY.

ARM Y worm is the popular name used to designate certain caterpillars which feed on many of our staple crops, sometimes completely defoliating them, and in such circumstances, from their habit of making wholesale migrations in search of other food supplies, they have earned for themselves this rather appropriate appellation. Army worms are of a dull greenish-brown colouration, and cause greatest damage in the warmer regions of the earth. It is not surprising, then, to find that sugar-cane, which is extensively grown in many of the warmer countries, is readily attacked by these pests in most places where it grows. In Queensland each year during the spring months, a certain amount of damage is caused to young cane by these pests, and these notes have been prepared for the purpose of informing canegrowers of the conditions under which the army worm pest assumes importance, their habits, and the best means of stamping them out, once they have assumed destructive proportions.

Army worms are the progeny of various inconspicuously-coloured moths, and these moths, after they emerge early in spring, soon commence to lay their eggs. Each female moth is capable of laying from 500 to 700 eggs, so it will be readily understood why the pest appears almost at once in such enormous numbers. The eggs are laid at the base of the leaves, behind the leaf-sheaths, under dead trash, or on any other weeds or debris adjacent to the cane stools. Untidy weedy fields therefore often predispose a field to attack, and much can be done to prevent this by keeping the fields well cultivated. On hatching out, these caterpillars soon commence to eat the leaf blade, feeding mainly during the night, and hiding away under trash or in the centre of the leaf spindle by day. During dull weather or in places where the food supply has become scarce, the caterpillars may be seen feeding during the day time, but this is not usual. Large irregular pieces are eaten out of the leaf blade, and in severe infestations nothing remains but the hard, bare midribs. (See Fig. 7, page 39.)

Often these infestations occur in a scattered manner throughout a field of cane, and when the food supply has become depleted in one locality, the caterpillars migrate to nearby fields, eating every green blade in front of them, and then, indeed, they become "army worms" in the true sense of the word. The caterpillar stage usually lasts about a month, but as the early spring brood of moths emerge and lay their eggs over a somewhat prolonged period, it has been our experience to find caterpillars in all stages of growth in the canefields; and, in consequence, young cane is continuously harassed by these pests. When fully developed, army worms are about $1\frac{1}{2}$ inches in length, and they then retire between the layers of trash, or burrow into the ground to a depth of a few inches, and transform to the chrysalis stage. After a period of about ten days as a chrysalis, during which time a process of reconstruction takes place, the moth emerges, and thus the entire life cycle occupies a period of about two months. After further egg-laying, the process of destruction proceeds once more.

So quickly do these pests increase, that they would soon get completely out of hand were it not for the number of natural enemies that attack them during all stages of their life. Several kinds of wasps and flies utilise them for the development of their young, and also as food, whilst many kinds of birds devour large numbers of them. These wasps and flies, which in the early spring months, are comparatively scarce, have usually bred up in fairly large numbers by December, so that they soon reduce the army worm population to relatively small numbers. This fact, combined with the increased vigour of the cane at that time, usually prevents the remaining few caterpillars from inflicting any great damage after that month.



FIG. 7.—A TYPICAL RATOON SHOOT EATEN BY "ARMY WORMS."

However, prior to the period when these friendly insects are able to exercise their full control, army worm attack frequently becomes a real menace to young cane, and is responsible for a marked retardation in growth, sometimes setting the crop back by as much as two months. In Queensland, damage occurs between August and November, and although the caterpillars themselves may not be visible, the first sign

of their attack is the jagged appearance of the leaf blades, and the accumulation of a crumbly greenish-brown excrement around the central spindle and the base of the leaves. If, by unfurling the central spindle, or by lifting up any trash lying at the base of the stool, large numbers of these insects are exposed, or if the caterpillars are migrating towards a field of cane, some form of control must be instituted to prevent destruction of the crop.

One method of preventing attack by a migrating horde of army worms is to plough a fairly deep furrow in front of the advancing army with the vertical face of the furrow nearest to the crop to be protected. Deeper pits are then dug at intervals along this furrow, about 20 feet apart. The army worms crawl into the furrow, and being unable to scale the vertical wall in front of them, they move off along the length of the furrow, and eventually fall into the pits. Later, these pests may be killed in the pits by some mechanical means, or by the application of small quantities of kerosene.

Another method is to spray all vegetation a chain wide in front of the army worms with arsenate of lead (5 lb. to 100 gallons of water). The burning of cane trash also helps to keep them under control, but this is not advisable in areas where trash cultivation yields good results.

Where army worms are already established in a field of cane, the most popular and efficient means of destroying them is by means of the bran poison bait, details of which are supplied below. The following ingredients are necessary:—

Bran	..	..	..	..	..	25 lb.
Paris Green or White Arsenic	..	..	..	..	..	1 lb.
Molasses	..	..	..	..	..	2 quarts
Water	..	..	..	..	..	2 gallons
The juice of six lemons or oranges.						

The Paris Green or White Arsenic is thoroughly mixed with the bran while dry, so as to get some of the poison in contact with each particle of bran. The lemon juice, together with the molasses, is added to and mixed in with some of the water, and this liquid is then poured evenly over the poisoned bran, and the whole mass mixed thoroughly. The remainder of the water can then be added a little at a time, until the bait becomes of the right consistency—i.e., when, by squeezing together in the hand it will not run through one's fingers, but adhere and not be too crumbly when pressure has been relaxed.

This bait is lightly but evenly distributed along the infested cane rows from about 4 p.m. until sundown, so as to guard against the bait drying out too rapidly. About 15-20 lb. of this mixture is sufficient to bait an acre if applied sparingly. The army worms feed on the bait during the night, and in a few days scarcely a live one can be found if the programme has been carried out correctly.

Last year we were able to demonstrate the value of this poison bait in a field where the grower wished to conserve the trash. Army worm infestation was particularly severe. So much so, that although ratoon shoots were being produced, they were eaten off just as quickly as they appeared, and the grower was in danger of losing his crop. The bran poison bait was resorted to, and at the same time adequate checks were kept on which no poison was applied. In a few days hundreds of caterpillars were found dead under the trash, and in a week's time

the baited rows showed green leaves, whereas the untreated rows were still being eaten. So pleased was the grower with the result, that he applied poison bait to the remaining untreated portions of the block of 6 acres, and although this destroyed the value of the trial from the point of view of gathering crop statistics from the treated and untreated portions later on, still the results were unquestionable. At the present time the mill estimate for this crop is 26 tons per acre, and it is not unreasonable to assert that had the area not been baited, the ratoons would have been several tons per acre lighter.

On account of its cheapness and efficacy, we can unhesitatingly recommend the bran poison bait to all growers troubled with the army worm pest, and would further suggest that good cultivation and the judicious use of fertilizers may do much to improve a crop which has been damaged by these pests.

Absorption of Arsenic by the Cane Crop.

In conjunction with the utilisation of arsenic as a grub control measure in the Giru area, the question was raised as to whether the absorption of this poison by the crop would endanger the purity of the raw sugar manufactured therefrom. Samples of cane were selected from a block which had been treated with arsenic at the rate of 200 lb. per acre. On analyses, Badila was found to contain only 1 part of arsenic in 3,000,000 parts of cane, while a sample of E.K. 28 contained only one-half this amount.

It is, therefore, safe to conclude that there is no danger of poisoning of the sugar crop due to this treatment, but it yet remains to be proved whether arsenic possesses the grub-control virtues which are claimed for it in the Giru district.

Cane Samples for Small Mill Tests.

It has been the practice of the Bureau to accept cane samples from canegrowers, for the purpose of determining the state of maturity of their crops, and thus giving an indication of the sequence in which respective blocks should be cut.

Of recent times, many of the samples which have been submitted are totally worthless for the purpose, and we would remind growers that unless the following requirements are complied with, samples will *not* be tested.

The sample shall consist of six stalks or 20 lb. of cane, whichever is the greater. Samples of burnt cane will not be accepted in any circumstances. When samples are forwarded over the railway, freights must be pre-paid.

We would again remind growers of the true purpose of these tests, and make it quite clear that our results are not intended for use in checking mill returns.

A New Disease of Cane in North Queensland.

By ARTHUR F. BELL.

DURING the progress of a disease survey of North Queensland early in 1929, shortly after the formation of the Division of Pathology, we began to form the opinion that in addition to leaf-scald there was present a similar, but distinct disease. On various occasions we found leaf symptoms similar to those of leaf-scald disease, but could find none of the confirmatory symptoms usually associated with leaf-scald. Owing to the very wide distribution of leaf-scald throughout North Queensland one could never be certain that it was not present in any particular instance, and consequently there was always the possibility that these particular leaf markings were but variations of the symptoms of leaf-scald. Laboratory tests failed to confirm this possibility, and although the isolation and culture of the causal bacteria of leaf-scald is a simple matter, in this case no such causal organism could be demonstrated. This possibly new disease was accordingly provisionally termed "pseudo-scald," and its presence recorded in the Annual Report for 1929.

In the meantime, it was learned that an apparently similar disease had attracted attention in Java about the same time, and in 1930 a short account of a new disease was published by the Pathologist of the Hawaiian Sugar Planters' Association. A study of this account left little doubt that the diseases of Hawaii and Queensland were identical; however, during the International Conference of Sugar Cane Technologists in March, 1932, the Pathologists of Java, Hawaii, and Queensland met in Porto Rico, and there found a disease which each identified as being exactly similar to the new disease of his particular country. Furthermore, in Porto Rico, unlike these other three countries, the situation was not complicated by the presence of true leaf-scald and so the symptoms could be recorded with certainty. There can now be no doubt that these four countries, at least, have this disease in common, and that it is quite distinct from leaf-scald. In Java it has been known as "fourth disease," while in Hawaii it was termed "chlorotic streak" disease.

Last spring, with the assistance of Mr. H. G. Knust, of the Tully Cane Pests Board, we were able to obtain a small supply of Badila which was infected with this pseudo scald, or chlorotic streak disease, and which we were quite sure (knowing the complete history of the field) had not leaf-scald disease. Cuttings were brought to Brisbane and planted in the Pathology Plot, one-half of the cuttings being planted without treatment while the other half were given warm water treatment before planting. The cane was planted on 30th August, 1932, and the treated cuttings germinated about one week ahead of the untreated. In spite of frequent watering the very young untreated cane wilted badly in the middle of the day while the treated cane remained turgid and continued to grow at a greater rate than the untreated. When the cane was three months old the characteristic leaf streaks (see page 44, and Fig. 8) began to appear in odd leaves of the untreated stools; they

remained visible until the cane was seven to eight months old but could not be found at any later date. Fourteen of the sixteen untreated stools bore these leaf symptoms, while not a single streak was ever observed in the stools arising from the treated cuttings. It is evident then that in this particular experiment, as was found in Hawaii, warm water treatment for twenty minutes at 52 deg. Centigrade had enabled the plants to throw off the disease.



FIG. 8.

Typical leaf streaks. In B are shown the more usual narrow type of streak and one of the broader, more diffuse type. Note wavy outline, variable width, and fragmented nature of streaks. In A is shown portion of an older streak in which the tissue has commenced to die; the ashy coloured centre and reddish border of this zone are well illustrated.

Throughout their whole life the stools from the warm water treated cuttings maintained a much more rapid rate of growth than the untreated stools, and when harvested at twelve months old the former greatly out-yielded the latter. The difference in yield will be appreciated on reference to the two photographs reproduced in Figs. 9 and 10. In Fig. 9 we have a photograph taken at the junction of the two lots of cane, that from the treated cuttings growing to the left of the plot peg, while the stunted stools from the untreated cane lie to the right. A very marked difference in the height of the cane, which could scarcely be due to soil differences, is apparent in the immediately adjacent stools. Parallel with the difference in height of the stools was a marked difference in the stooling habit, the untreated cane averaging three stalks per stool while the treated averaged five stalks per stool. The first twelve stools on either side of the peg were then harvested and placed in two heaps, and again the difference in yield is brought out by the second photograph (Fig. 10); the larger heap on the left is composed of cane cut from twelve stools of treated cane while that on the right is the cane from a similar number of stools from untreated cuttings.

Undoubtedly quite a startling difference in yield has been obtained by the planting of the diseased cuttings in contrast to diseased cuttings rendered apparently healthy by warm water treatment. Of course it is well known that warm water treatment of normal cuttings has a stimulating effect on germination (and so on growth), so that if untreated healthy cane had been used the difference obtained may not have been so great. Furthermore, this experiment was carried out in the temperate zone, where Badila is usually cropped as a two-year old cane, and the difference in yield might not have been nearly so great if the experiment had been conducted in the wet tropical belt. Nevertheless the difference in yield is so great as to demand further investigation, and accordingly two field trials have already been planted, one in the Tully area and one in the Mulgrave area. In the former warm water treated diseased Badila is being grown in plots side by side with the untreated cane, while in the latter, diseased and healthy (Tableland Nursery Badila, not treated) cane are being compared.

The symptoms of the disease are easy to describe; the chief difficulty often is to find them in the diseased plant. The leaf symptoms as found in Badila are illustrated in Fig. 8. They consist of long, narrow, cream to white, longitudinal streaks in the blade of the leaf, ranging in width from 1-16 to 3-16 inch and rarely being of uniform width throughout their length (see Fig. 8B). They run in the direction of the veins of the leaf and may extend the whole length of the leaf but more frequently are less than 1 ft. in length, and are often fragmented. In older streaks the leaf tissue within the boundaries of the streaks frequently dies and assumes an ashy-grey colour surrounded by a narrow reddish border (see Fig. 8A); these dead areas are at first small but may later extend almost the whole length of the streak. They may be distinguished from the typical young streaks of leaf-scald by the wavy outline and varying width, as compared with the sharply defined uniform streaks of leaf-scald. In the later stages leaf-scald streaks become broad and diffuse, with broad dead areas extending in from the margins, but this is not the case with the disease in question. The streaks do not pass from the leaf blade down on to the leaf sheath as in leaf-scald, while the latter streaks are rarely, if ever, fragmented.



FIG. 9.

Striking effect of warm water treatment of cuttings of Badila cane affected with this disease. The larger stools on the left of the white plot peg grew from treated cuttings and remained apparently healthy throughout the life of the crop, while the stunted stools to the right of the peg were obtained from untreated cuttings and bore numerous typical leaf streaks. Cane growing in Pathology Plot, Brisbane.

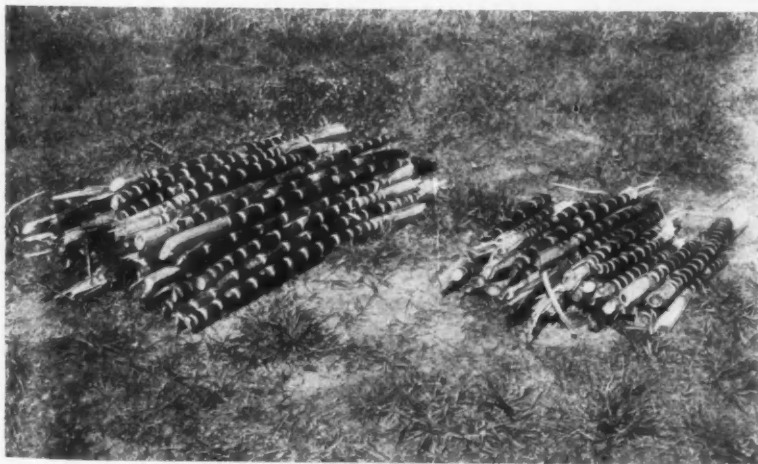


FIG. 10.

The cane harvested from 12 stools grown from treated cuttings (left) and 12 stools grown from untreated cuttings (right). See also Fig. 9.

Upon cutting open diseased stalks a few reddened fibres may be found but they are not numerous. None of the confirmatory symptoms of leaf-scald, such as side shooting, almost complete loss of green leaf colour, or death of mature cane, can be found.

The leaf symptoms as here described and illustrated are best found in Badila when the young crops are just commencing to make cane—about October-November. As the cane grows higher they frequently disappear, and by the following March it may be impossible to find a single leaf-streak in a field which is known to be approximately 100 per cent. diseased. The streaks are most apparent on the older leaves but they are often not at all numerous, in fact quite frequently only a single leaf streak can be found in the whole stool.

The origin of this disease is not known, but its wide-spread distribution proves that it has been in the country for many years. It has been found in places throughout the area north of Cardwell but a shortage of Field Staff has prevented a farm to farm survey to determine the percentage of farms affected. Its presence has been reported, but not confirmed, on a few farms in the Mackay district, and has definitely been recorded in a field of Badila ratoons on the Maroochy River. In the far north, Badila is, of course, the variety chiefly affected, but the disease has also been recorded in P.O.J. 2722, P.O.J. 2875, P.O.J. 2878, and S.C. 12/4. In Hawaii it has been observed on the following varieties:—P.O.J. 36, P.O.J. 213, P.O.J. 234, P.O.J. 979, P.O.J. 2714, P.O.J. 2727, P.O.J. 2878, E.K. 28, H. 109, Co. 213, Yellow Caledonia (Malabar), D. 1135, Badila, and a number of the newer Hawaiian seedlings.

The means by which this disease is spread from diseased to healthy plants is not yet known and is the subject of investigation both here and in Hawaii. Observations made so far indicate that the rate of spread is slow and that if healthy planting material is used that is all that is necessary to control the disease in most cases. In the meantime it is suggested that North Queensland farmers, particularly, be on the lookout for the disease during the next two or three months, and note its presence or absence in their fields. Should the two field trials at Tully and Mulgrave confirm the indications obtained in the small Pathology Plot trial, they will then be in a position to decide whether they are in need of fresh supplies of planting material, and make plans accordingly.

Seedling Propagation.

With the object of securing superior varieties which carry with them resistance to diseases, the Bureau annually propagates about 20,000 seedlings. The cross pollination work is performed at South Johnstone and Freshwater, and selections of seed therefrom are germinated at all three of our Experiment Stations. Approximately 10,000 selected seedlings are planted each year at the South Johnstone Station, and 5,000 at each of the Central and Southern Stations.

In this way it is hoped to propagate and select new canes specifically adapted to the peculiar environmental conditions in which they will ultimately be grown.

The Wireworm Pest in the Mackay and Proserpine Cane Fields.

By W. A. McDougall.

ALTHOUGH damage by wireworms has been reported in other Queensland cane districts, at the present time it is most serious in the Mackay and Proserpine Mill areas. Here whole fields, or large parts of fields, may fail to give strikes, whilst in other instances the misses may be lightly distributed throughout blocks, or may be confined to small or large patches or to the lower ends of the fields.

Damage by wireworms was noticed in some fields around Mackay at least as early as 1890. However, during the last fifteen years the planting to cane of considerable areas of low, badly-drained country has increased the percentage of fields subject to bad strikes caused by wireworms, and also has brought before the notice of farmers in general one type of insect which could, so it seems, at any time be responsible for misses. The results of this latter happening have been a tendency to blame wireworms for some damage for which they are not actually responsible and the popularising of superficial observations which have been of no use in the controlling of the pest; in fact, in some instances, they have been much the reverse.



FIG. 11.

A poor stand of cane in a badly-drained depression. The eyes have been destroyed by wireworms.

It so happens that moth borers, grubs, and the Pentodon Beetle cause "dead-hearts," and both the grubs and adults of the last-mentioned attack cane setts and eyes. The result is very similar to wireworm damage, and is likely to occur in any type of field. Again, wireworm species of the yellowish semi-flattened type with brown ends all more or less look alike, and they may be found in nearly every Mackay canefield and also in grass paddocks. It must be remembered, however, that even species belonging to the same genus and inhabiting the same fields may behave in different ways. Sometimes false wireworms,

of which there are a few in Mackay fields, are mistaken for wireworms. Occasionally the wireworm species living in the higher well-drained fields will attack a sett or two, but the serious pest species is confined, in numbers sufficient to cause extensive damage, to badly-drained country. Without obscuring the issue it might be mentioned that very occasionally a brown cylindrical wireworm attacks cane planted in mattock holes on hillside country. This species does not occur in ploughed fields. Also, when first planting new lands inclined to be badly drained, three or four species will be found to be damaging eyes. For subsequent plantings all but one species will have disappeared; those which have gone prefer grass lands only. When the one low-land species is under control, damage by wireworms in the Mackay and Proserpine Mill areas will be negligible.

Wireworms are notoriously immune to poisons, and no parasites or predators of any economical value are known. Usually efforts are made to find a suitable cultural control. This means that a detailed knowledge of the life history and habits of the particular pest species must be obtained. Any cultural control suggested for one species need not be of much use for the combating of other wireworms.

Working with the pest species in the Mackay and Proserpine areas it has been found that fertilizers are of little use in its control, and getting the plants away quickly does not solve the problem satisfactorily. The growing of green manure crops has very little to do with any wireworm infestations, provided the field has been properly drained, and there is no correlation between the percentage organic matter in the soil and the occurrence of wireworm damage. No particular grass attracts the pest. Although the wireworm pest is most common in low land, drainage as usually practised around Mackay is of no avail. Here bedding up is done just prior to planting, by which time the wireworms (most of the eggs are laid from December to February) have become well established in the field. If the land to be planted were properly drained before the wet season immediately prior to planting (in fact from November on), the pest species could not breed extensively. Its young stages require excessive moisture for their development. Wireworm damage is most prevalent during the plantings following heavy wet seasons.

By August many of the wireworms are fully fed, and those still feeding do not feed as frequently as do most of the instars present in the fields during the earlier months of the year. Generally the life cycle occupies one year.

Briefly summing up, it may be said that —

1. One species is responsible for most of the wireworm damage in the areas referred to above, and it desires a very damp habitat during the early part of its existence.
2. Once the pest becomes established in the field there is no cure known; some relief may be got by very late plantings.
3. There is a preventative; thorough drainage during the wet season immediately prior to planting. Even then it is best to plant late in what was known, previous to the drainage, to be very bad "wireworm" country.

To date results from this method of control have been very satisfactory.

The Control of Diseases in Young Plant Cane.

By W. COTTRELL DORMER.

THE control of sugar-cane diseases is best accomplished before the cane is planted, by the use of resistant varieties and of healthy plants. However, circumstances sometimes make these control measures difficult to follow. Thus it may not be possible to obtain a sufficient supply of resistant canes or, because of the peculiar soil or climatic conditions of their farms, these canes may not seem desirable to certain growers. It is for these growers especially that this article is written, and to those who have been unable to obtain perfectly healthy plants, since a good deal can be done to control some diseases while the cane is young.

The principal measure adopted in control of diseases of this kind is known as "roguing," which means the digging out of diseased stools. Besides roguing, weeding and the elimination of undesirable plants from the vicinity of canefields, and also the use of discretion in the application of certain fertilizers, have a bearing on the control of cane diseases. Before dealing specifically with any one disease we will discuss briefly the fundamental facts or principles upon which these measures are based.

The first and most important of these facts is that all of the diseases which are to be considered are infectious. That is why roguing is practised. Let us explain further what is meant. In everyday life we sometimes hear the illness of some unfortunate person being discussed. If we are not sure of the nature of the trouble one of the first questions we ask is: "Is it catching?" If it is catching, most of us keep out of the way or else the unfortunate is himself put out of the way until he is free from the disease. We keep clear of the patient or lock him up somewhere because we know that if we don't do one of these things we stand quite a good chance of catching the disease ourselves. But what is the position in a field of sugar-cane? Can all the healthy stools run off to some other part of the paddock when they discover that their neighbour is suffering from an attack of Fiji Disease or has caught Mosaic somewhere or other? Obviously not. Unless the farmer or his employee comes along with a spade or a mattock and destroys the diseased stool, the healthy ones will have to put up with the risk of infection. That is what we mean by roguing—we locate the centres of infection and then eradicate them. Of course, common sense must be employed in this as in any other operation on the farm; it would be foolish to rogue where, say, half of the stools were diseased. We generally suggest that roguing be restricted to fields with 5 per cent. or less of diseased stools. Excepting where a new outbreak of some serious disease is being dealt with, it is doubtful whether it would be worth while roguing where more than one in twenty stools are diseased.

A second very important fact is that certain serious diseases are transmitted from plant to plant by insects; such diseases are said to have an insect vector. Where we know definitely which insect is responsible, it will be evident that any measure which will discourage that insect from travelling from diseased to healthy plants will be worth putting into practice, provided that the measure is economically sound.

The third fact which must be mentioned is that, in the case of one disease at least—namely, Mosaic—the insect carrier of the disease is not a sugar-cane insect. It ordinarily lives on other related plants which are also able to contract the disease. We call these other plants alternate hosts. The insect in question only goes to sugar-cane when disturbed by wind or by cultivation. If, then, we can keep the plants away from the canefields we also go a long way towards keeping our fields free from outside sources of infection.

Finally, before discussing each disease in detail, we must refer to the influence of fertilizers. Here we are dealing rather with a principle than with a detailed practice. I am referring especially to the use of nitrogenous fertilizers such as sulphate of ammonia and nitrate of soda. It is well known that when used in excess these fertilizers lead to a rapid succulent growth. This type of growth favours the spread of two diseases in plant cane—namely, Fiji Disease and Red Stripe—though in rather different manners. It is for this reason that discretion should be exercised in the use of fertilizer.

Let us now see how we can make use of our knowledge in the control of some of the diseases which must be looked for in young plant cane. As space is rather limited, a brief reference only can be made to the symptoms of each disease. Most growers to-day have quite a fair knowledge of these symptoms. To those who are desirous of further information we would point out that the Bureau of Sugar Experiment Stations is at their service and that any inquiry will meet with prompt attention.

DOWNY MILDEW.

This disease, which is sometimes referred to as Leaf Stripe, commonly occurs in certain parts of the Bundaberg, Mackay, and Burdekin districts, though it is not restricted to these areas. The varieties most frequently affected are B. 208, B. 156, P.O.J. 2714, and P.O.J. 2878. Downy Mildew, as seen in young plant cane, is characterised by yellow stripes in the leaves. On the under side of these stripes is found a powdery white fungus. This fungus is the causal agent of the disease, and sheds minute spores during the night, which are distributed by air currents and serve to infect healthy cane. The remedy, at this stage, is to dig the stools out at once, before the rainy season commences, and to cut them up so that they will dry out rapidly and cease being a source of danger to neighbouring stools.

FII DISEASE.

As far as is known, this disease is restricted to certain areas of the Beenleigh, Maroochy, Maryborough, and Bundaberg districts. It is a serious disease and is of especial importance because, besides D. 1135 and M. 1900 Seedling, the list of susceptible canes includes P.O.J. 2878 and others of the same lineage which are showing high resistance to gumming disease. We wish to emphasise that if Fiji Disease is permitted to remain unchecked, the time will surely come when we will be unable to grow certain canes which offer wonderful promise of eliminating losses from Gumming, which in the past has been our most serious disease.

Fiji disease is very easy to recognise. If the disease is present in a field, stunted stools will be found. The under side of the leaves of these stools should be carefully examined, and if the stunting is due to

Fiji disease, elongated swollen galls or lumps will be seen. The next thing to do is to rogue—to destroy systematically every diseased stool that can be found. If the Bureau has not already been communicated with this should be done, as the disease is very serious, and no effort should be spared in eradicating it.

It has recently been demonstrated by officers of the Bureau that Fiji disease is transmitted by the common sugar-cane leaf-hopper. This insect increases very greatly in numbers from December onwards, and, therefore, it is essential that the roguing programme should be completed before this increase in insect population takes place.

MOSAIC.

This is probably the best known of all cane diseases in the southern and central districts. While it attacks to a greater or less extent almost all varieties of cane, it is especially common in D. 1135, M. 1900 Seedling, and Black Innes. Its symptoms consist of a light-green mottling of the younger leaves. As has already been mentioned, it is insect-borne, the insect being the common corn aphid which normally dwells on corn, sorghum, Johnson grass, and other grasses which commonly occur as weeds in canefields. These plants are also alternate hosts for the disease.

Knowing these things, it will be realised that control of the disease must be proceeded with very early. As far as possible fields and headlands should be kept free from weeds from the time the field is planted until the cane is out of hand. Also, diseased stools should be dug out and the growing of corn or sorghum near the canefield must be avoided. As far as the weeds are concerned, it is realised that weather conditions in some localities make systematic weeding impossible. In such cases the growing of resistant canes should be gone in for, as very little can be done to control Mosaic in young plant cane once weeds have become established.

RED STRIPE.

This disease occurs chiefly in the central and northern districts, where it is also commonly known as Top Rot. It is a disease which attacks principally young succulent cane, and especially so if it has been checked during its earlier history. Roguing is of no use here. What should be aimed at, then, is the maintaining of steady-growing conditions as far as possible. Fertilizer should be used during the early spring months, but preferably not after October. If a farm is under irrigation the water should be kept up—it is a bad policy to wait until the leaves begin to wilt before applying water, as that kind of check encourages Red Stripe. In other words, do all that can be done to develop strong healthy stools before the hot weather comes, and after that the use of nitrogenous fertilizers should be discontinued. These measures will not entirely eliminate Red Stripe but will go a long way towards minimising losses.

CONCLUSION.

In conclusion, a few more words will be added on the subject of roguing. First of all, it is of no use digging out a stool and throwing it between the rows if wet weather is liable to come and enable it to take root once more; the stool must be broken up so that it will dry

out quickly. Secondly, it should be realised that one roguing is seldom sufficient; roguing should be carried out on several consecutive occasions—once a week if possible—otherwise some stools are bound to be missed. Finally, a most important word of advice to all growers whose fields require roguing: Don't put off the job until some other day; that day is usually slow in coming. The earlier roguing is carried out the better—perhaps most growers have already started. If not, there is only one thing to do—that is, *do it now*.

NOTE ON CANE-KILLING WEED.

Although not a disease in the sense understood above, it is thought that a short note on the Cane-killing Weed will not be out of place, since it is while the cane is young that the weed should be controlled. Where stunted patches occur in a field of cane, especially in forest country, and the stunting cannot be ascribed to disease or to soil conditions, the Cane-killing Weed should be looked for. It is a small upright plant with a squarish stem, rather narrow dark-green leaves, and is covered with very short rough spines. Below the ground surface its stem is pale purple to white in colour, and its roots have small nodules where the plant attaches itself to cane roots.

Where this parasite is found the hoe should at once be called into operation and the infected patches kept quite free from weeds of any kind, since the parasite is also able to live on certain grasses. Another control method which could be tried is that used in India. In that country success has been obtained by soaking the soil, where the weed occurs, to a depth of 2 or 3 inches with a 2 per cent. solution of copper sulphate. The important thing is to prevent the weed from flowering and setting seed which may be washed into other fields with drainage water.

Influence of Arrowing on the Maturity of Cane.

Certain views are held by canegrowers regarding the significance of arrowing, particularly in relationship to its influence on crop maturity. Thus it is frequently stated that the crop is ready for the knife six weeks after arrowing.

That there is no justification for such a statement is amply borne out by the results of maturity tests which we are at present conducting on certain newly imported canes from Java. One of these—P.O.J. 2725—showed 100 per cent. arrows in May last. Progressive analyses show that the cane has undergone a normal course of maturity, and on 18th September the average c.e.s. (small mill test) was 16.4 per cent. with no indication that the crop was deteriorating. Thus the cane has improved its sugar content for four months following arrowing.

Certainly a crop which has flowered can make no further stalk growth, but beyond this fact there appears to be little in the views so freely expressed. In a season such as the present, when prolonged crop growth leads to delayed maturity, it is possible that arrowing may be something of an advantage.

Ratooning of Sugar Cane.

By H. W. KERR.

A STUDY of the cane yields for Queensland over the past ten years shows that the average yield per acre is approximately 17 tons. When a further analysis is made of the relative returns from plant and ratoon crops, it is found that plant cane gives a much higher yield than the average, but there is a marked reduction in that of the succeeding ratoons. This is particularly true of the drier and older areas of the State, where it is frequently found that the ratoon yield is barely 50 per cent. of that of the plant crop. When it is remembered that the costs of cultivating ratoons are appreciably lower than those for plant crops, it is here that the grower should aim at producing his cheapest cane, consistent with other considerations. It is, therefore, proposed to review the situation—to discuss the factors which operate against high ratoon yields, and decide whether there is any justification for the marked discrepancy in yields which are so commonly experienced.

As regards growing conditions, the plant crop has many points in its favour. Prior to planting, the land has, in general, passed through a period of fallow, with or without a leguminous cover crop, and the several ploughings and harrowings which the land receives are calculated to reduce the soil to a condition of good tilth and provide a favourable seed bed. The fact that no crop has been removed from the land for a season ensures some measure of relief from the drain on the plantfood supplies of the soil, and the new crop finds a reasonable amount of available plantfood for its early needs, even where no fertilizer is applied. Further, the grower is able to choose, in general, a favourable time for the planting of the crop, when soil moisture is adequate and air temperatures sufficiently high to ensure a rapid germination and vigorous early crop growth. In planting the cane the grower aims at placing his setts at a depth of from six to eight inches in the soil, so that the young crop roots may develop in that portion of the seed bed which is protected from rapid drying out by evaporation of moisture from the soil surface.

In contrast with these factors, the early life of the ratoon crop is frequently anything but a happy one. When the plant cane is harvested, the ratoons develop immediately, irrespective of whether soil moisture, temperature, and plantfood supply are particularly favourable or not. For their early growth, the shoots draw on the sugar and plantfood reserves which have been stored up in the stubble, and it is noteworthy that the development of these shoots is generally much more rapid than is the case with plant cane. In this respect conditions favour the ratoons, by reason of the extra food storage which is possible, and also of the much greater number of buds or eyes which the stubble possesses in comparison with a cane sett.

That, however, is as far as the advantage extends; much of the ratooning is done during the months of August, September, and October—notably the driest months of the year. During this period soil moisture deficiency is generally acute even in the more humid areas. Consequently, the young ratoon shoot roots as they develop, encounter a parched surface soil from which they can derive little in the way of moisture and plantfood.

The situation is often aggravated by reason of the tightly compacted nature of the soil at this time. The older soils of our cane areas exhibit almost uniformly a tendency to "run together" when wet, and the beating action of the heavy wet season's rains, coupled with the trampling of working animals and the subsurface packing action of implements, tend to leave the surface soil in such a condition that drying out is accelerated, and the dry soil is practically unworkable until rain falls.

Undoubtedly the first consideration of the farmer, with respect to ratooning, is to pay careful attention to soil moisture conservation during these dry months. Such scanty moisture as is present in the soil at harvest time is all the ratoons have to subsist on until rain falls.

Another important aspect of the problem must also be carefully considered. It was pointed out that the cane sett is placed, in the first instance, at such a depth in the seedbed, that the young roots are assured of being able to draw on the full soil moisture supply. If one should study the nature of young ratoon shoots, it would be found that they, in general, originate from the uppermost undamaged eyes of the stubble. It is obvious, then, that the young and tender roots developing from the base of these shoots will come in contact first of all with the upper inch or two of the surface soil; in dry weather, this is most completely baked and dried out and the young ratoons must inevitably suffer under these conditions. The remedy for this trouble readily suggests itself; it is obviously most desirable that the ratoon shoots should spring from those underground-buds situated on the lower portion of the stubble; in this way the ratoon stool will be set more deeply in the soil, and the root system will be developed where any available moisture is located. The only way to effect this is to damage or destroy the uppermost eyes of the stubble. This is usually effected by the use of bumper disc harrows which are drawn across the ratoon field immediately the plant crop trash has been burnt off; although the implement is not intended for the purpose, it does effect a moderately satisfactory job. A machine that was especially designed for this work has been employed with success in overseas cane countries; this implement is known as the stubble-shaver, and its essential parts are two horizontal discs which are driven from the rear axle of the machine as it passes down the cane row. The height of the discs may be regulated to cut off a pre-determined amount of the stubble, and thus remove the upper eyes as desired. One of these machines was imported recently by the Bureau from Hawaii, and is at present being demonstrated throughout the cane areas.

The nett effect of the operation of either of the implements mentioned is to reduce the number of ratoon shoots which develop in each stool. When it is remembered that of the numerous spindly top shoots which normally appear in a ratoon field, only a small proportion find their way to the mill at harvest time, this must be regarded as something of an advantage; for the food reserves in the stubble are then preserved for use by only those shoots which will grow to millable cane. As a consequence, it is usually found that the more desirable bottom shoots are much thicker and sturdier than normal, and in turn will stool out in the same way as the primary shoot of a plant crop.

It should be stressed that the cutting away of the top portion of the stubble is successful only when an adequate stool has been produced

in the growth of the plant crop. To this end it is absolutely essential that the plant cane drill be kept open until the crop is well stooled before filling in. Any attempt to cut back a stool which is located on the surface of the land will invariably prove fatal to the ratoon yield, as nothing is left in the soil. This is particularly true with shy stooling varieties, such as Q 813. The fact that the success of the ratoons is intimately related to the manner of development of the plant crop cannot be too strongly emphasised.

A common ratooning practice in Queensland is the operation known as "ploughing away"; by this process a furrow is run close to each side of the row of stools, and the soil is thus exposed to the action of the sun and wind—a treatment which, it is claimed, "sweetens" up the soil and improves the ratoons. This theory cannot be sustained in practice, and in dry areas at least, the policy should be strongly discouraged. The soil under these conditions breaks up in clods which rapidly dry out, and the exposed sides of the stool are similarly affected. Doubtless the practice encourages the development of the lower stubble shoots, but should no rain fall, the subsequent operation of working down the middles after several days' exposure throws this mass of dry hard clods up to the stools, to provide a most unfavourable medium for the development of the ratoon roots.

Certainly the middles must be worked up to a state of good tilth as soon as possible after the ratoon crop starts; but in so doing, great care must be taken to guard against loss of soil moisture. It is found that this job may be most satisfactorily performed by the use of the subsoiler, the grubber, or the skeleton plough. By the use of such implements it is possible to till the soil well, without opening it up to the drying action of sun and wind.

Another factor which operates most seriously against successful ratoon growth is plantfood deficiency. It has been pointed out that a season's fallow makes for at least a modest accumulation of plantfood for the use of the plant cane; but when this crop has been harvested the surface soil has been very completely permeated by the crop roots, which have gathered in as much as possible of the available nutrients to be built up in the crop tissues and transported to the mill. The young ratoons are, therefore, at a serious disadvantage, and unless provision is made for an early application of fertilizer to supply the deficiency, the crop will suffer a serious check from which it does not completely recover. In substantiation of these remarks, the results from the farm fertility trials harvested by the Bureau during the past three years are of interest. Taking the results as a whole from all cane areas of the State, it is found that the average increased yield due to fertilizer on plant cane was $4\frac{1}{2}$ tons of cane per acre; on the subsequent ratoon crops, however, the increase was $7\frac{1}{2}$ tons of cane, on the average. These figures emphasise, in a most striking manner, the absolute necessity for careful attention to the plantfood supply for ratoons. The actual values themselves are also interesting; the average yield for fertilized ratoons was 21 tons of cane per acre, while the unfertilized plots gave but $13\frac{1}{2}$ tons.

The kind of fertilizer used is also of great importance; the mixture should be appropriately balanced with respect to its potash and phosphate content, and the published results of our fertility trials afford a useful guide in this respect. As regards the need for the

third plant food—nitrogen—it is found that deficiencies of this nutrient probably effect a more serious reduction in ratoon yields than any other individual factor. In the heavy rainfall belt at least, it is found that applications up to 600 lb. of sulphate of ammonia per acre show profitable returns, and on the irrigated lands of the Burdekin, it has been demonstrated that the growth of successful ratoons is not possible if adequate dressings of this plant food are not applied.

Further, the best results from artificial manures will be attained only when the fertilizer is applied early in the growth of the crop, and an application of mixed fertilizer at ratooning time, placed close to the stools and at a depth of 3 or 4 inches, is imperative. This may be followed, at intervals of from 4 to 6 weeks with top dressings of sulphate of ammonia, each of, say 1 bag per acre, until the desired application of nitrogen has been supplied.

To summarise then the sequence of ratooning operations which will ensure the best results, the following are briefly the most important considerations:—

Immediately the trash from the plant crop is burnt off, the soil should be surface cultivated to conserve the available moisture. It is well appreciated that, following the fire, the immediate surface soil is almost invariably sufficiently moist to permit of a satisfactory job, if done instantly. If the bumper discs are employed for the purpose, the destruction of the upper eyes of the stool is effected at the same time.

As soon as the line of stools is clearly defined, the grubber or subsoiler should be brought into operation to work up the soil to a depth of 8 or 10 inches. A further harrowing may be necessary to reduce the larger soil masses to a finer condition of tilth.

An adequate dressing of mixed fertilizer should next be applied alongside the row of stools by the use of a distributing machine. As the shoots develop, further top dressings of sulphate of ammonia should be given at brief intervals until the full application has been made. With the advent of rains, cultivation implements should be freely used to loosen the soil and destroy the weed growth; and it should be remembered that successful ratoons require just as careful treatment as successful plant crops.

In conclusion, a note of censure should be struck against the all too prevalent practice of burning plant crops before harvest; under these conditions, the exposure of the bare land surface to the drying action of sun and winds while the balance of the block is being harvested, makes it practically impossible to effect a satisfactory ratooning job in a dry season, and the succession of unfavourable crops is perpetuated.

Disease Resistance Trials.

Six hundred and fifty new varieties, including 620 seedlings raised by the Bureau, have been planted in gumming disease resistance trials this season, while a further 600 seedlings were planted in leaf-scald resistance trials. The object of these trials is to determine the resistance of certain selected seedlings and imported canes, but mainly to discover which particular crosses are likely to yield disease-resistant progeny.

The Tachinid Fly.

By J. H. BUZACOTT.

THE tachinid fly parasite of the cane beetle borer was originally recorded in New Guinea by Mr. Henry Tryon, who was at that time Queensland Government Entomologist. Owing to increasing damage to sugar-cane by borers in Hawaii, entomologists were sent from that country to travel through the eastern islands to seek parasites with a view to controlling it, and the tachinid fly was eventually located in New Guinea by Mr. Muir, of the staff of the Hawaiian Sugar Planters' Association Experiment Station. It was in 1910 that Muir established fly-breeding cages at Mossman, in Queensland, and also at Fiji in an endeavour to transport the parasites from New Guinea to Hawaii, these two intermediate stations being necessary on account of the short life-cycle of the fly, and it was from flies which escaped from the Mossman cages that the borer in that area first became infested with the parasite. A further introduction of flies from Fiji was made by the Colonial Sugar Refining Company during 1914, in order to try and minimise the damage caused by cane borers at South Johnstone, and from these two importations the tachinid fly has become firmly established throughout North Queensland.

For a period of more than ten years the fly has been bred at the Meringa Experiment Station for the purpose of supplying farms subjected to borer attack, and, at various times, the Colonial Sugar Refining Company has conducted breeding cages for the same purpose. This year, in order to ensure if possible that every farm suffering from borer damage shall have also the parasite, the method of cutting out fly puparia in the fields where it has become firmly established, has been adopted. Just before cutting such a field, badly bored sticks are opened and the puparia of the parasites removed, these puparia then being taken to Meringa and hatched under special conditions; the flies, when they hatch, are transferred to farms in the localities where they are required.

Due almost wholly to the control exerted by the parasite, borer damage has been considerably lessened during the past ten years, whereas, had the fly not been introduced, it is more than probable that in certain districts the c.e.s. and tonnage of the cane would be so reduced by borers as to render cane growing unprofitable. It must not be supposed that the fly will ever completely eliminate the borer; it can, however, be expected to reduce the borers to such a percentage that the damage they cause will be negligible. Borers in the butts of the cane usually escape the parasite, as the common small brown field ant, which is to be found at the base of most stools, preys on the maggots of the fly. However, butt damage is rarely serious, and the same brown ant also destroys most of the borers in the butt, which helps to make up for the parasites it destroys.

In order to assist farmers in recognising and preserving the tachinid fly, a short description of the species and its method of working is appended:—

The adult parasite is a fly somewhat smaller than the common house-fly, and has an almost black body conspicuously barred with white. The female fly is capable of producing over 1,000 eggs, which usually

hatch inside the body and are deposited as very minute maggots at the small holes made in the rind of the cane by the borers when they are tunnelling. One of these holes is cut just before the borer pupates, in order to provide easy access for the beetle when it emerges, and this accounts for the fact that by far the greater percentage of parasitised borers are fully grown. The fly maggots make their way through the orifice into the borer tunnel and thence into the body of the borer, which may harbour from one to fifteen maggots, the average being three. When the presence of the parasite has reduced the vitality of the borer to a certain degree, the latter forms a cocoon of cane fibres in the same way as for normal pupation, but by this time the interior of the body of the borer has been consumed by the maggots, and instead of the borer pupa being found within the cocoon, the small dark-brown puparia of the tachinid fly are discovered. These puparia remain as such for about fifteen days, and then the flies hatch out and make their way to the external world through the hole which the borer has already made for the exit of the beetle. From the depositing of the maggot to the hatching of the fly from the puparia, the life-cycle of the fly requires from five to six weeks, and its rapid increase is due to this short life period.

The most severe check on the work of the tachinid fly is that period of the year when all the cane has been cut, for whereas the borers can carry over in the underground portion of stools and the borer beetles may live for months, the fly rarely parasitises the borers in basal portions and the life of the adult fly is only a few days. Consequently, unless special precautions are taken, the parasites may easily be lost from a farm. In order to prevent this happening it is essential that small blocks of borer-infested cane be allowed to stand over each season to act as sanctuaries in which the flies may continue to breed. This provides a plentiful supply of the parasites to control the borers as they appear in the young growing cane. Where this is carried out—and the block of standover need be no larger than one twenty-fifth of an acre—the beetle borer is rapidly brought under control, and, more important, kept there.

The puparia obtained for dispersal this year were collected by kind permission from Mr. Jackson's farm at Babinda, and his help has been of the utmost assistance to us. Further batches of puparia are to be collected, and large liberations made in the Gordonvale, Babinda, Innisfail, and Tully districts, these being the districts where most of the serious borer damage occurs.



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